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ANALYSIS OF LSD-41 MACHINERY ROOM LAYOUT.(U)
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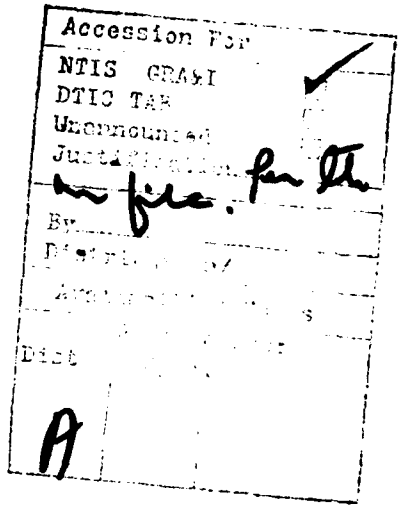
FOREWORD

This analysis was conducted as a preliminary step in the development of machinery rooms for the LSD-41. Tentative layouts of the machinery rooms had been prepared by both NAVSEA and the J. J. Henry Company. This report describes the advantages and disadvantages of the concepts depicted in these layouts. A key factor involved in selecting one concept over the other is the extent to which they conform to established human engineering principles and practices.

RICHARD C. SORENSON
Director of Programs



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INTRODUCTION

Problem

Tentative layouts for the LSD-41 machinery rooms #1 and #2 have been developed by NAVSEA and by the J. J. Henry Company.[1] Figures 1 and 2 provide approximate sketches of the NAVSEA layouts; and Figures 3 and 4, of the J. J. Henry layouts. A key factor involved in selecting one set of drawings over the other is the extent to which they conform to established human engineering principles and practices.

Objective

The objectives of this analysis were to identify and discuss the advantages and disadvantages of the NAVSEA and J. J. Henry layouts, and to recommend changes to eliminate, insofar as possible, the disadvantages.

ASSUMPTIONS

A number of assumptions have been made in conducting the analysis. These assumptions are based on the results of interviews with NAVSEA and J. J. Henry engineers, established human engineering principles, and interviews with naval personnel who are familiar with operating procedures in the engineering spaces of naval ships. The assumptions are as follows:

1. The bulk of the LSD-41 machinery, including diesels and auxiliary boilers, is located on the lower levels of the machinery rooms. Thus, it follows that (a) maintenance of equipment will be conducted primarily on the lower levels, and (b) local operating stations for the diesels will be located on the lower levels.

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[1]References to plans are as follows: Naval Sea Systems Command, Drawing No. 802-5363769, LSD-41 Class, Arrangement of Machines Plan, View Upper Level (undated), and J. J. Henry Company, Work Task Assignment No. 0002-10, Drawing No. 0002-10-2, Arrangement of Machinery in Main and Auxiliary Rooms No. 1 and 2, 2 June 1979.

2. The consoles in the Main Engineering Operating Stations (MEOS) #1 and #2 must be identical in order to minimize procurement costs, facilitate training, and maximize ease of operation by operators when assigned from one MEOS to the other.

3. Important controls and indicators should be located on the consoles immediately in front of the operator to minimize the amount of head and body movement required to operate and monitor them. Frequent scanning of indicators on the periphery of the console (up, right, and left of the operator) should not be required. Extensive research on motion sickness has shown that frequent head motion orthogonal to body motion generates coriolis forces that can rapidly induce motion sickness.[2]

4. To minimize the coriolis effect, the consoles should be located so that the operator faces forward, rather than port or starboard, when operating and monitoring the primary controls and displays. An operator facing port or starboard would experience more body motion than would an operator facing forward.

5. Engineering supervisory personnel will occupy the MEOSs when they are not required to be in the machinery spaces. Consequently, ready access to ladders leading to the lower levels of the machinery rooms is necessary to facilitate entry to these levels during emergencies.

COMPARISON OF LAYOUTS

NAVSEA Layout

Advantages

1. The NAVSEA layout permits the use of identical wrap-around consoles in MEOS #1 and #2.

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[2]Newman, R. A. Ship Motion Effects in the Human Factors Design of Ships and Shipboard Equipment (NPRDC Tech. Rep. 77-2). San Diego: Navy Personnel Research and Development Center, November 1976. (AD-A031 978)

2. A seated operator in MEOS #1 can view the machinery space by rotating in his chair 180°.

3. The ladders to the lower level are somewhat more accessible than are those in the J. J. Henry layout.

4. Operators seated at the consoles are located slightly nearer to the centerline of the ship.

Disadvantages

1. The console in MEOS #2 fills the entire forward area, thus preventing the installation of a window to enable the operator to view the machinery space.

2. The orientation of the two MEOSs differ. In MEOS #1, the operator has his back to the machinery space; in MEOS #2, he faces the machinery space.

J. J. Henry Layout

Advantages

1. In both MEOS #1 and MEOS #2, the seated operator faces the machinery space. Orientations of the machinery space relative to the operator are more nearly alike than in the NAVSEA layouts.

2. Configuration of the J. J. Henry MEOS #2 is better than that of the NAVSEA MEOS #2. Because of the location of the console in the J. J. Henry layout, a window overlooking the machinery space can be installed.

Disadvantages

1. The use of identical wrap-around consoles is not feasible. If the console is placed so as to permit a window to be installed overlooking the machinery space, as in Figure 4, one wing of the console would extend out into the room. This would restrict movement of personnel and communication among personnel.

2. Ladders to the lower level are not immediately accessible to the MEOSs.

DISCUSSION

Although it is not essential for the seated operator to directly view the machinery space, installing windows overlooking this area is considered worthwhile for psychological reasons. Because of the minimal amount of information that could be obtained from such windows, however, development of special consoles that would permit their installation in the NAVSEA MEOS #2 is not warranted.

The wrap-around console has a slight advantage over the straight console, since it permits a seated operator to scan all indicators merely by rotating his body in the chair. Under no circumstances, however, should the indicators be located so as to require frequent scanning of the full console. This would require an excessive amount of head and body motion, which would far outweigh the minor advantage derived from the better visibility of indicators on the wrap-around console.

In both the NAVSEA and J. J. Henry layouts, it appears that the ladders to the lower levels should be repositioned. Further study of the machinery layout on the lower level is needed to determine the optimum locations of the ladders.

If the NAVSEA layouts are adopted, the MEOS #2 should be modified to approximate the layout presented in Figure 5, which would permit the installation of forward-looking windows overlooking the machinery space. If the J. J. Henry layouts are adopted, straight consoles should be used, as indicated in Figures 6 and 7. Satisfactory results should be obtained with either the NAVSEA layouts with wrap-around consoles or the J. J. Henry layouts with straight consoles. Provided that the recommended changes are made, final selection of the layouts should be based on factors other than human engineering.

CONCLUSIONS AND RECOMMENDATIONS

1. If the NAVSEA layouts are selected, MEOS #2 should be modified to resemble the layout in Figure 5. Wrap-around consoles may be used.

2. If the J. J. Henry layouts are selected, straight consoles as in Figures 6 and 7 should be used.

3. Windows should be installed in the MEOSs as depicted in Figures 1, 5, 6, and 7.

4. Further study should be conducted to determine the optimum locations of ladders to the lower levels.

5. Development of special consoles to permit a seated operator to observe the machinery space over the top of the consoles is not warranted.

6. Controls and indicators should be located on the console so as to minimize the amount of head and body motion required in scanning the console.

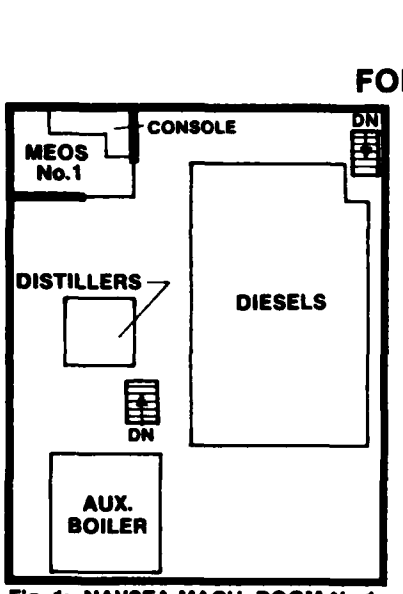


Fig. 1: NAVSEA MACH. ROOM No.1

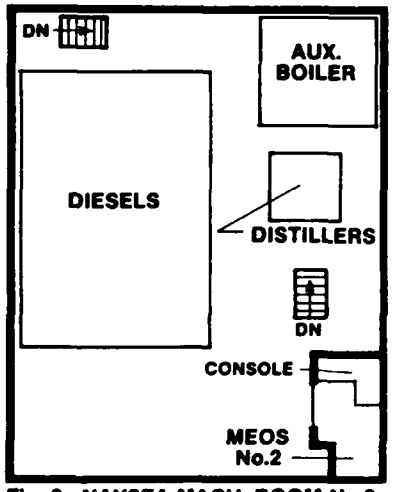


Fig. 2: NAVSEA MACH. ROOM No.2

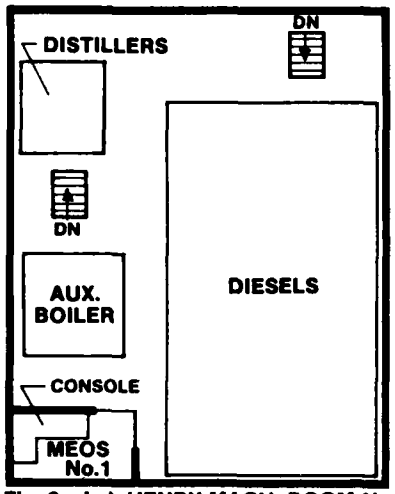


Fig. 3: J. J. HENRY MACH. ROOM No.1

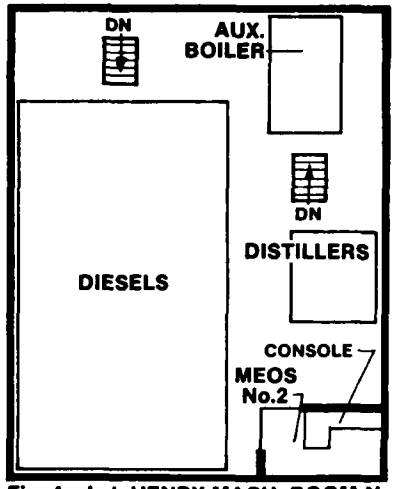


Fig. 4: J. J. HENRY MACH. ROOM No.2

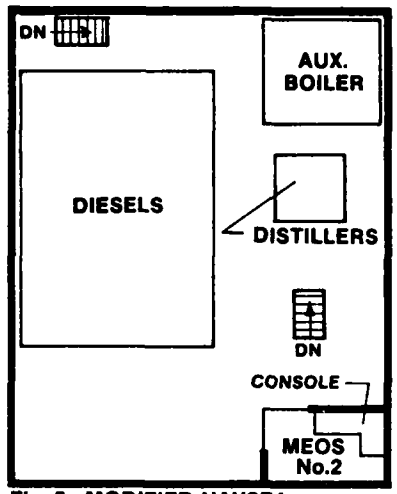


Fig. 5: MODIFIED NAVSEA MACH. ROOM No.2

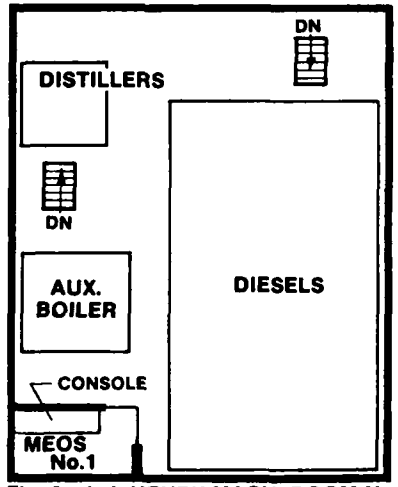


Fig. 6: J. J. HENRY MACH. ROOM No.1 WITH STRAIGHT CONSOLE

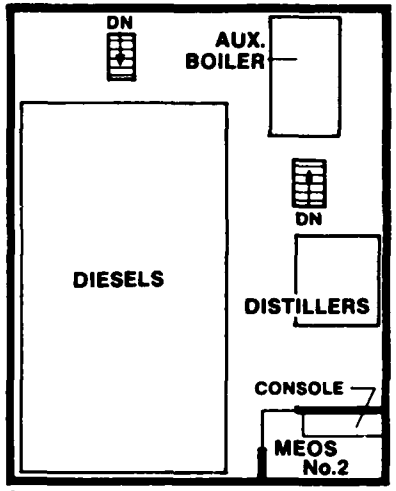
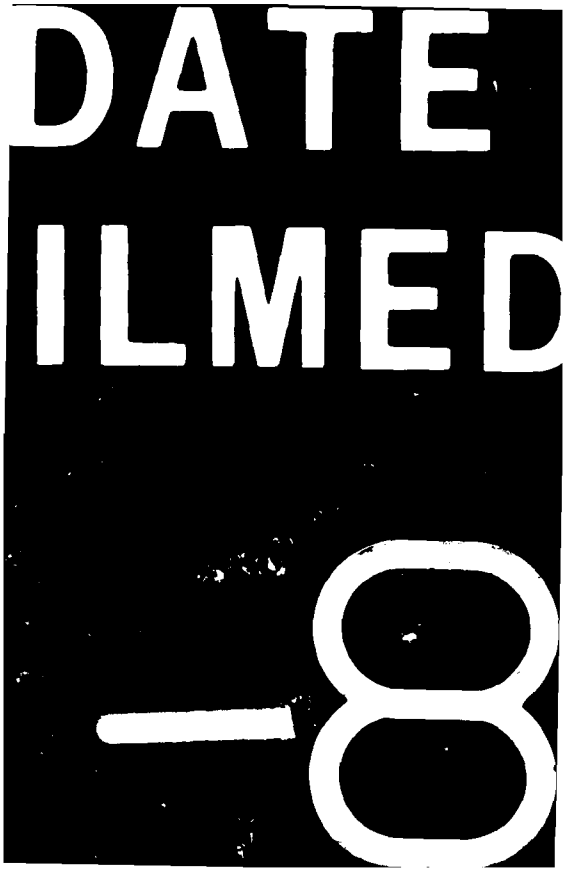


Fig. 7: J. J. HENRY MACH. ROOM No.2 WITH STRAIGHT CONSOLE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